Ch 9 Stoichiometry

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↳ mass Relationships in chemical Rxns

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Molar Ratio

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Molar Ratio $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

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$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

1 atom Zn 2 moles HCl 1 fu $ZnCl_2$ 1 mole H_2

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Molar Ratio

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

1 atom Zn : 2 moles HCl : 1 fu $ZnCl_2$: 1 mole H_2

Coeff's tell us #'s of moles, fu, atoms Reacting

Ch 9 Stoichiometry

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Molar Ratio

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

1 atom Zn 2 molec HCl 1 fu $ZnCl_2$ 1 molec H_2

Coeff's tell us #'s of molec, fu, atoms Reacting

2 atom Zn

Ch 9 Stoichiometry

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Molar Ratio

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

1 atom Zn 2 moles HCl 1 fu $ZnCl_2$ 1 mole H_2

2 atom Zn 4 " HCl

Coeff's tell us #'s of moles, fu, atoms Reacting

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Molar Ratio

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

1 atom Zn 2 moles HCl 1 fu $ZnCl_2$ 1 mole H_2

2 atom Zn 4 " HCl → 2 " $ZnCl_2$ 2 " H_2

Coeff's tell us #'s of moles, fu, atoms Reacting

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Molar Ratio

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

1 atom Zn 2 molec HCl 1 fu $ZnCl_2$ 1 molec H_2

Coeff's tell us #'s of molec, fu, atoms Reacting

2 atom Zn 4 " HCl → 2 " $ZnCl_2$ 2 " H_2

6×10^{23} atoms Zn

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Molar Ratio

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

1 atom Zn : 2 molec HCl : 1 fu $ZnCl_2$: 1 molec H_2

Coeff's tell us #'s of molec, fu, atoms Reacting

2 atom Zn : 4 " HCl → 2 " $ZnCl_2$: 2 " H_2

6×10^{23} atoms Zn : 1.2×10^{24} molec. HCl

Ch 9 Stoichiometry

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Molar Ratio

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

1 atom Zn : 2 molec HCl : 1 fu $ZnCl_2$: 1 molec H_2

Coeff's tell us #'s of molec, fu, atoms Reacting

2 atom Zn : 4 " HCl → 2 " $ZnCl_2$: 2 " H_2

6×10^{23} atoms Zn : 1.2×10^{24} molec HCl : 6×10^{23} fu $ZnCl_2$: 6×10^{23} molec H_2

Ch 9 Stoichiometry

↳ mass Relationships in chemical Rxns

Molar Ratio

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

Coeff's tell us #'s of molec, fu, atoms Reacting

1 atom Zn | 2 molec HCl | 1 fu $ZnCl_2$ | 1 molec H_2

2 atom Zn | 4 " HCl → 2 " $ZnCl_2$ | 2 " H_2

6×10^{23} atoms Zn | 1.2×10^{24} molec HCl | 6×10^{23} fu $ZnCl_2$ | 6×10^{23} molec H_2

1 mol Zn | 2 mol HCl → 1 mol $ZnCl_2$ | 1 mol H_2

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Molar Ratio

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

Coeff's tell us #'s of moles, fu, atoms Reacting

1 atom Zn | 2 moles HCl | 1 fu $ZnCl_2$ | 1 mole H_2

2 atom Zn | 4 " HCl → 2 " $ZnCl_2$ | 2 " H_2

6×10^{23} atoms Zn | 1.2×10^{24} moles HCl | 6×10^{23} fu $ZnCl_2$ | 6×10^{23} moles H_2

1 mol Zn | 2 mol HCl → 1 mol $ZnCl_2$ | 1 mol H_2

✱ Coefficients mean #'s of moles !!!

$4P + 5O_2 \rightarrow 2P_2O_5$

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Molar Ratios
What is molar Ratio of:

P to O_2

P to P_2O_5

O_2 to P_2O_5

Inverse?

$4P + 5O_2 \rightarrow 2P_2O_5$

Molar Ratios
What is molar Ratio of:

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4 mol P : 5 mol O_2

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Molar Ratios
What is molar Ratio of:

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$\frac{4 \text{ mol } P}{5 \text{ mol } O_2}$

O_2 to P_2O_5

$\frac{5 \text{ mol } O_2}{2 \text{ mol } P_2O_5}$

P to P_2O_5

Inverse?

$4P + 5O_2 \rightarrow 2P_2O_5$

Molar Ratios
What is molar Ratio of:

P to O_2

~~$4 mol\ P : 5 mol\ O_2$~~ $\frac{4 mol\ P}{5 mol\ O_2}$

O_2 to P_2O_5

$\frac{5 mol\ O_2}{2 mol\ P_2O_5}$

P to P_2O_5

$\frac{4 mol\ P}{2 mol\ P_2O_5}$

Inverse?

$4P + 5O_2 \rightarrow 2P_2O_5$

Molar Ratios
What is molar Ratio of:

P to O_2

$\frac{4 mol\ P}{5 mol\ O_2}$ ~~$4 mol\ P : 5 mol\ O_2$~~

O_2 to P_2O_5

$\frac{5 mol\ O_2}{2 mol\ P_2O_5}$

P to P_2O_5

$\frac{2 mol\ P}{1 mol\ P_2O_5}$

Inverse)

$\frac{5 mol\ O_2}{4 mol\ P}$ $\frac{2 mol\ P_2O_5}{5 mol\ O_2}$

mol-mol stoichiometry

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$$2KClO_3 \longrightarrow 2KCl + 3O_2$$

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what is the molar Ratio of $KClO_3$ to Oxygen?

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$$\frac{2\ mol\ KClO_3}{3\ mol\ O_2}$$

mol-mol stoichiometry

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what is the molar Ratio of $KClO_3$ to Oxygen?

$$\frac{2\ mol\ KClO_3}{3\ mol\ O_2}$$

Molar Ratio can be used as conversion factors!

mol-mol stoichiometry

$$2KClO_3 \longrightarrow 2KCl + 3O_2$$

If 4.0 mol of $KClO_3$ decompose, How many moles of Oxygen can Be produced?

mol-mol stoichiometry

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mol-mol stoichiometry

$$2KClO_3 \longrightarrow 2KCl + 3O_2$$

If 4.0 mol of $KClO_3$ decompose, How many moles of Oxygen can Be produced?

$4.0\ mol\ KClO_3 \times \frac{\quad}{mol\ KClO_3}$

mol-mol stoichiometry

$$2KClO_3 \longrightarrow 2KCl + 3O_2$$

If 4.0 mol of $KClO_3$ decompose, How many moles of Oxygen can Be produced?

$$4.0\ mol\ KClO_3 \times \frac{mol\ O_2}{mol\ KClO_3}$$

mol-mol stoichiometry

$$2KClO_3 \longrightarrow 2KCl + 3O_2$$

If 4.0 mol of $KClO_3$ decompose, How many moles of Oxygen can Be produced?

$$4.0\ mol\ KClO_3 \times \frac{3\ mol\ O_2}{2\ mol\ KClO_3}$$

mol-mol stoichiometry

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$$4.0 \text{ mol } KClO_3 \times \frac{3 \text{ mol } O_2}{2 \text{ mol } KClO_3} =$$

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If 4.0 mol of $KClO_3$ decompose, How many moles of Oxygen can Be produced?

$$4.0 \text{ mol } KClO_3 \times \frac{3 \text{ mol } O_2}{2 \text{ mol } KClO_3} = \boxed{6.0 \text{ mol } O_2}$$

mol-mol stoichiometry

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Molar Ratio used as conversion!

mol-mol stoichiometry

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If 4.0 mol of $KClO_3$ decompose, How many moles of Oxygen can Be produced?

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If 3.92 mol O_2 are produced, How many mol of KCl were produced?

mol-mol stoichiometry

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mol-mol stoichiometry

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If 4.0 mol of $KClO_3$ decompose, How many moles of Oxygen can Be produced?

$$4.0\ \text{mol}\ KClO_3 \times \frac{3\ \text{mol}\ O_2}{2\ \text{mol}\ KClO_3} = 6.0\ \text{mol}\ O_2$$

If 3.92 mol O_2 are produced, How many mol of KCl were produced?

$$3.92\ \text{mol}\ O_2 \times \frac{2\ \text{mol}\ KCl}{3\ \text{mol}\ O_2} = 2.64\ \text{mol}\ KCl$$

$$Na_2SO_3 + CaCO_3 \rightarrow Na_2CO_3 + CaSO_3$$

If 2.73 mol Na_2SO_3 React, How many mol of $CaCO_3$ are also need in the Rxn?

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$$2.73 \text{ mol } CaCO_3 \times \frac{g\,CaCO_3}{\text{mol } CaCO_3}$$

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$$2.73 \text{ mol } CaCO_3 \times \frac{100 \text{ g } CaCO_3}{1 \text{ mol } CaCO_3}$$

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$$2.73 \text{ mol } CaCO_3 \times \frac{100 \text{ g } CaCO_3}{1 \text{ mol } CaCO_3} = 273 \text{ g } CaCO_3$$

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mol – mass stoichiometry

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mol A (given) $\xrightarrow{\text{Molar Ratio}}$ mol B (asked for)

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mol A (given) $\xrightarrow{\text{Molar Ratio}}$ mol B (asked for) $\xrightarrow{\times \text{ g B} \,/\, 1 \text{ mol B}}$ g B

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

If 10.0 mol of H_2O are produced in the Rxn above, How many g of C_3H_8 were combusted?

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

?g 10.0mol

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$$10.0\text{mol } H_2O \times \frac{1\text{mol } C_3H_8}{4\text{mol } H_2O}$$

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?g 10.0mol

If 10.0mol of H_2O are produced in the Rxn above, How many g of C_3H_8 were combusted?

$10.0\,mol\,H_2O \times \frac{1\,mol\,C_3H_8}{4\,mol\,H_2O}$

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If 10.0mol of H_2O are produced in the Rxn above, How many g of C_3H_8 were combusted?

$$10.0\,\text{mol}\,H_2O \times \frac{1\,\text{mol}\,C_3H_8}{4\,\text{mol}\,H_2O} \times \frac{44\,\text{g}\,C_3H_8}{1\,\text{mol}\,C_3H_8} =$$

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

?g 10.0mol

If 10.0mol of H_2O are produced in the Rxn above, how many g of C_3H_8 were combusted?

$$10.0\,\text{mol}\,H_2O \times \frac{1\,\text{mol}\,C_3H_8}{4\,\text{mol}\,H_2O} \times \frac{44\,\text{g}\,C_3H_8}{1\,\text{mol}\,C_3H_8} = 110\,\text{g}\,C_3H_8$$

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

If 3.47 g O_2 React,
How many mol of H_2O
are produced?

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

mass to mol stoich

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$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

3.47 g O_2 ; ? mol H_2O

mass to mol stoich

If 3.47 g O_2 React,
How many mol of H_2O are produced?

3.47 g O_2 x

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

3.47 g O_2 ; ? mol H_2O

mass to mol stoich

If 3.47 g O_2 React,
How many mol of H_2O are produced?

$$3.47\ g\ O_2 \times \frac{1\ mol\ O_2}{32\ g\ O_2}$$

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

3.47 g O_2 ; ? mol H_2O

mass to mol stoich

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Step 1: convert g A to mol A

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

3.47 g O_2 ; ? mol H_2O

mass to mol stoich

If 3.47 g O_2 React,

How many mol of H_2O are produced?

$3.47\ g\ O_2 \times \frac{1\ mol\ O_2}{32\ g\ O_2} = 0.108\ mol\ O_2$

Step 1: convert g A to mol A

$$C_3H_8 + \underset{0.108\,mol}{5O_2} \rightarrow 3CO_2 + \underset{?\,mol}{4H_2O}$$

mass to mol stoich

If 3.47 g O_2 React,

How many mol of H_2O are produced?

$$3.47\,g\,O_2 \times \frac{1\,mol\,O_2}{32\,g\,O_2} = 0.108\,mol\,O_2 \times \frac{4\,mol\,H_2O}{5\,mol\,O_2} =$$

Step 1: convert gA to molA

$$C_3H_8 + \underset{0.108\ mol}{5O_2} \rightarrow 3CO_2 + \underset{?\ mol}{4H_2O}$$

mass to mol stoich

If 3.47 g O_2 React,

How many mol of H_2O are produced?

$$3.47\ g\ O_2 \times \frac{1\ mol\ O_2}{32\ g\ O_2} = 0.108\ mol\ O_2 \times \frac{4\ mol\ H_2O}{5\ mol\ O_2} = \boxed{0.0867\ mol\ H_2O}$$

Step 1: convert g A to mol A

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

O_2: 0.108 mol; H_2O: ? mol

mass to mol stoich

If 3.47 g O_2 React,

How many mol of H_2O are produced?

$$3.47\ g\ O_2 \times \frac{1\ mol\ O_2}{32\ g\ O_2} = 0.108\ mol\ O_2 \times \frac{4\ mol\ H_2O}{5\ mol\ O_2} = 0.0867\ mol\ H_2O$$

Step 1: convert g A to mol A

Step 2: use molar Ratio to convert mol A → mol B

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

$0.108\ mol$ $\quad$ $?\ mol$

mass to mol stoich

If 3.47 g O_2 React,

How many mol of H_2O are produced?

$$3.47\ g\ O_2 \times \frac{1\ mol\ O_2}{32\ g\ O_2} = 0.108\ mol\ O_2 \times \frac{4\ mol\ H_2O}{5\ mol\ O_2} = \boxed{0.0867\ mol\ H_2O}$$

Step 1: convert gA to mol A

Step 2: use molar Ratio to convert mol A → mol B

$$gA \xrightarrow{\times \frac{1\ mol\ A}{g\ A}} mol\ A$$

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

$0.108\ mol$ (under $5O_2$) ; $?\ mol$ (under $4H_2O$)

mass to mol stoich

If 3.47 g O_2 React,

How many mol of H_2O are produced?

$$3.47\ g\ O_2 \times \frac{1\ mol\ O_2}{32\ g\ O_2} = 0.108\ mol\ O_2 \times \frac{4\ mol\ H_2O}{5\ mol\ O_2} = 0.0867\ mol\ H_2O$$

Step 1: convert gA to mol A

Step 2: use molar Ratio to convert mol A → mol B

$$gA \xrightarrow[\times \frac{1\ mol\ A}{g\ A}]{} mol\ A \xrightarrow[\text{Ratio}]{\text{Molar}} mol\ B$$

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

mass-mass Stoich

If 4.78 g of HCl reacts w/ $CaCO_3$, what mass of CO_2 is produced?

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mol A $\xrightarrow{\times \text{Molar Ratio}}$ mol B

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If 4.78 g of HCl reacts w/ $CaCO_3$, what mass of CO_2 is produced?

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

mol A $\xrightarrow{\times \text{Molar Ratio}}$ mol B

g A $\xrightarrow{\times \frac{1\text{ mol A}}{\text{g A}}}$ mol A $\rightarrow$ mol B

mol A $\rightarrow$ mol B $\xrightarrow{\times \frac{\text{g B}}{1\text{ mol B}}}$ g B

mass-mass Stoich

If 4.78 g of HCl React w/ $CaCO_3$, what mass of CO_2 is produced?

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g A $\xrightarrow{\times \frac{1\text{ mol A}}{g\text{ A}}}$ mol A $\rightarrow$ mol B

mol A $\rightarrow$ mol B $\xrightarrow{\times \frac{g\text{ B}}{1\text{ mol B}}}$ g B

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

mol A $\xrightarrow[\text{Ratio}]{\times \text{Molar}}$ mol B

g A $\xrightarrow{\times \frac{1\text{ mol A}}{g\text{ A}}}$ mol A $\rightarrow$ mol B

mol A $\rightarrow$ mol B $\xrightarrow{\times \frac{g\text{ B}}{1\text{ mol B}}}$ g B

g A $\rightarrow$ mol A $\rightarrow$ mol B $\rightarrow$ g B

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If 4.78 g of HCl React w/ $CaCO_3$, what mass of CO_2 is produced?

4.78 g HCl

g A → mol A → mol B → g B

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

mass-mass Stoich

If 4.78 g of HCl React w/ $CaCO_3$, what mass of CO_2 is produced?

$$4.78\,g\,HCl \times \frac{1\,mol\,HCl}{36.5\,g\,HCl}$$

gA → mol A → mol B → g B

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

mass-mass Stoich

If 4.78 g of HCl Reacts w/ $CaCO_3$, what mass of CO_2 is produced?

$$4.78\,\cancel{g\,HCl} \times \frac{1\,mol\,HCl}{36.5\,\cancel{g\,HCl}} \times \frac{1\ mol\,CO_2}{2\ mol\,HCl}$$

gA → mol A → mol B → g B

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If 4.78 g of HCl React w/ $CaCO_3$, what mass of CO_2 is produced?

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If 4.78 g of HCl Reacts w/ $CaCO_3$, what mass of CO_2 is produced?

$$4.78\,g\,HCl \times \frac{1\,mol\,HCl}{36.5\,g\,HCl} \times \frac{1\,mol\,CO_2}{2\,mol\,HCl} \times \frac{44\,g\,CO_2}{1\,mol\,CO_2} =$$

gA → molA → molB → gB

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mass-mass Stoich

If 4.78 g of HCl React w/ $CaCO_3$, what mass of CO_2 is produced?

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gA → molA → molB → gB

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

mass-mass Stoich

If 4.78 g of HCl Reacts w/ $CaCO_3$, what mass of CO_2 is produced?

$$4.78\,g\,HCl \times \frac{1\,mol\,HCl}{36.5\,g\,HCl} \times \frac{1\,mol\,CO_2}{2\,mol\,HCl} \times \frac{44\,g\,CO_2}{1\,mol\,CO_2} = \boxed{2.9\,g\,CO_2}$$

gA → molA → molB → gB

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

mass-mass Stoich

If 4.78 g of HCl React w/ $CaCO_3$, what mass of CO_2 is produced?

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gA → molA → molB → gB

$2NaOH \longrightarrow H_2O + Na_2O$

How many g of NaOH were decomposed when 5.42 g of Na_2O were produced?

gA → mol A → mol B → g B

$2NaOH \rightarrow H_2O + Na_2O$

How many g of NaOH were decomposed when 5.42 g of Na_2O were produced?

$5.42\,g\,Na_2O \times \frac{1\,mol\,Na_2O}{62\,g\,Na_2O}$

gA → mol A → mol B → g B

$2NaOH \rightarrow H_2O + Na_2O$

How many g of NaOH were decomposed when 5.42 g of Na_2O were produced?

$$5.42\,g\,Na_2O \times \frac{1\,mol\,Na_2O}{62\,g\,Na_2O} \times \frac{2\,mol\,NaOH}{1\,mol\,Na_2O}$$

g A → mol A → mol B → g B

$2NaOH \longrightarrow H_2O + Na_2O$

How many g of NaOH were decomposed when 5.42 g of Na_2O were produced?

$$5.42\,g\,Na_2O \times \frac{1\,mol\,Na_2O}{62\,g\,Na_2O} \times \frac{2\,mol\,NaOH}{1\,mol\,Na_2O} \times \frac{40\,g\,NaOH}{1\,mol\,NaOH} = 7.0\,g\,NaOH$$

gA → mol A → mol B → gB